Main Features

- **High Sensitivity Full Frame CCD Sensor**
- **2300 x 3500 Resolution with 10 µm Square Pixels**
- **100% Aperture Pixels**
- **12-bit Dynamic Range**
- **Very Low Noise: 63 dB SNR**
- **Binning and ROI Modes**
- **LVDS Data Format**
- **High Data Rate: 25 Mpixels/s**
- **Flexible and Easy to Operate via RS232 Control**
  - **Trigger Mode: Free Run or External Trigger Modes**
  - **Binning 2x2 and 4x4, Up to 5 ROI**
  - **Exposure Time**
  - **Gain: x1 or x4**
  - **Tri Shot Color Operation**
- **Single Power Supply: DC 24V**
- **High Reliability – CE Compliant**
- **F (Nikon) Mount Adapter (Lens Not Supplied)**

Product Description

This camera is designed to meet high performance and quality requirements while providing easiness of use.

- ATMEL manages the whole chain, from the sensor to the camera. The result is a camera able to work in 12-bit, with a dedicated electronic offering an excellent signal to noise ratio.
- Because of the 100% aperture pixel the sensitivity of the camera is fairly high even in the near infrared.
- The programmable settings let the user works at different integration time and gain. External trigger allows to synchronise the camera on external event while tri shot color mode allows very high resolution for color image acquisition.

Applications

Performance and reliability of this camera make it well suited for the most demanding applications as film and document scanning, semiconductor and PCB inspection, DNA analysis, metrology, X-ray imaging, etc...

CAMELIA 8M

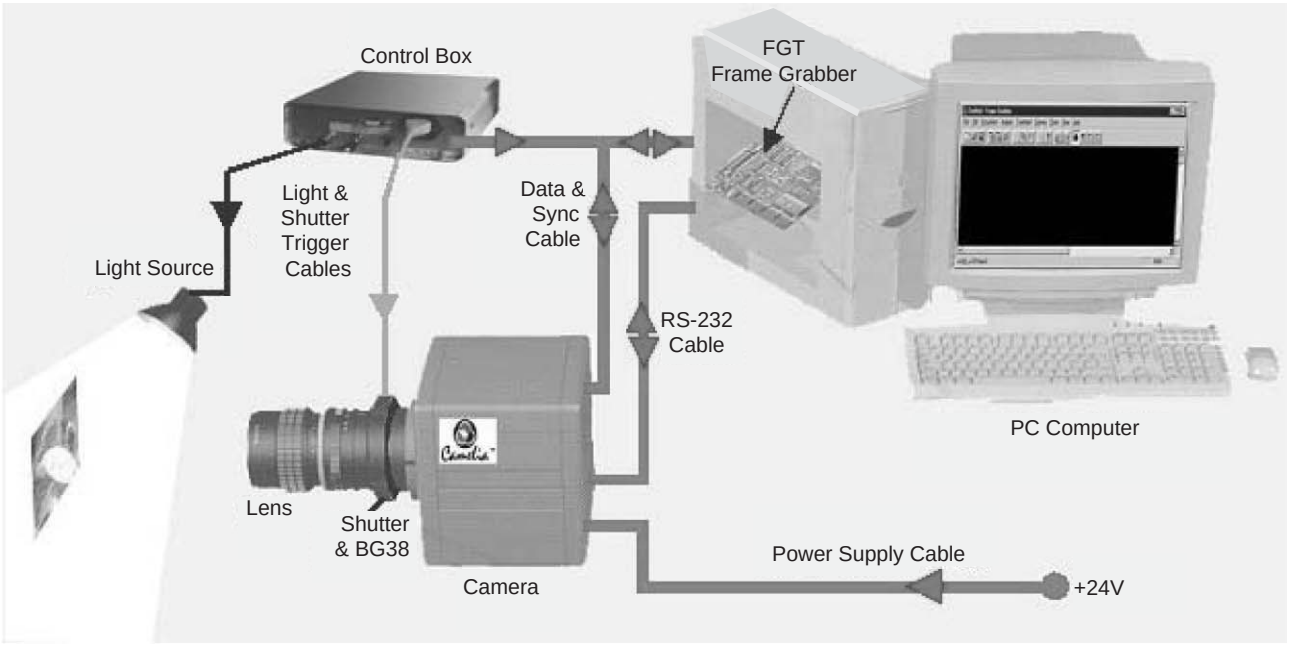
8 Megapixels Digital Camera

Camelia™

Rev. 1986B–IMAGE–03/03

Imaging System Description

Figure 1. Imaging System



CAMELIA camera is powered by a single +24V power supply.

CAMELIA camera is configurable via the serial port of the computer (by using either CommCam software or standard RS232 communicator as TTY or Hyperterminal).

CAMELIA camera sends digital video.

As CAMELIA's CCD is a full frame sensor, the user must use either pulsed lightning or a chopper/shutter in front of the camera in order to have incident lightning on the CCD only during integration time. The user must design an electro-optical interface to drive camera, shutter/chopper or lightning by using the "SHUTTER" signal delivered by the camera. If required, the system can send an external trigger or external ITC (integration time control signal) to the camera.

The BG38 Filter is essential to have a correct white balance on Color Cameras.

Note that the following Elements are not provided by ATMEL:

- Shutter (LCD or Mechanical)
- BG38 (Anti Infra Red) Filter
- Control Box
- Lens
- Light Source
- +24V Power Supply
- Computer

For a complete explanation of the utility of the BG38 Filter and the Shutter, please consult the associated FAQs and the example Images on the ATMEL CDROM "Camera Documentation & Software".

CCD Description

Image Format

35.0 mm (V) x 23.0 mm (H)

Active Pixels

Table 1. Active Pixels

Mode (set via RS232)	Image size (H x V)	Timing diagram correspondence
No binning	2300 x 3500	H = M V = N
2x2 pixel binning	1150 x 1750	
4x4 pixel binning	574 x 875	

Readout Register

Readout register along the small side of the image area (vertical image).

Pixel Geometry

Pixels are 10 µm x 10 µm with an aperture ratio of 100%.

Anti-blooming by Clocking

Anti-blooming can be activated or inhibited (see “RS232 Controls” on page 10):

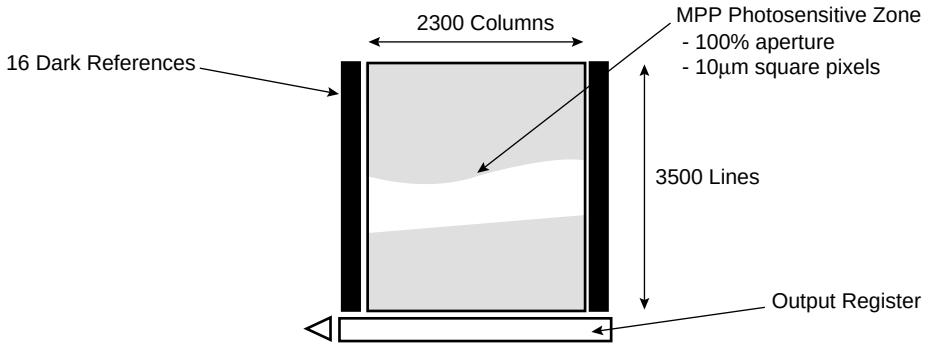
- Anti-blooming OFF: anti-blooming inhibited. This position is recommended if anti-blooming is not required for the application.
- Anti-blooming ON: anti-blooming activated.
- When binning is disabled, the anti-blooming is efficient until **8 times** the saturation Current.

Video Signal Processing Gain

Video signal processing gain can be adjusted by setting the "CDS gain" via RS232: a commutation 1x or 4x is available at the input of the video signal processing.

The 4x position is recommended for low level applications.

Figure 2. Video Signal Processing Gain



Timing

2x2 and 4x4 pixel binning are possible to enable previewing modes. Preview mode is only available in Black and white otherwise the user has to use Overlay mode (but neither correction nor software LUT are applicable on displayed images).

Table 2. Timing Mode

Mode	Frame Readout Time	Line Readout Time
No binning	370 ms	104 µs
2x2 pixel binning	200 ms	114 µs
4x4 pixel binning	110 ms	134 µs

Frame Timing

Three timing modes are available: Continuous, external triggered and Integration Time controlled (ITC).

The signals described in the following drawings are:

Table 3. Frame Timing

Signal	Name	Description	Cam. In/Out	Pins Connection
LEN	Line ENable	Low state active when pixel is part of line	Out	26/27
FEN	Frame ENable	Low state active when lines are part of frame	Out	3/4
SHUTTER	SHUTTER Sync	External shutter Trig output Sig. (high level active)	Out	21/22
TRIG	TRIGger	External Trigger Input Signal (Rising Edge)	In	46/47
ITC	Integration Time Control	External ITC Input Signal (Falling/Rising Edges)	In	46/47
PCK	Pixel Clock	Internal Master Data Clock Signal at 25 MHz	Out	1/2

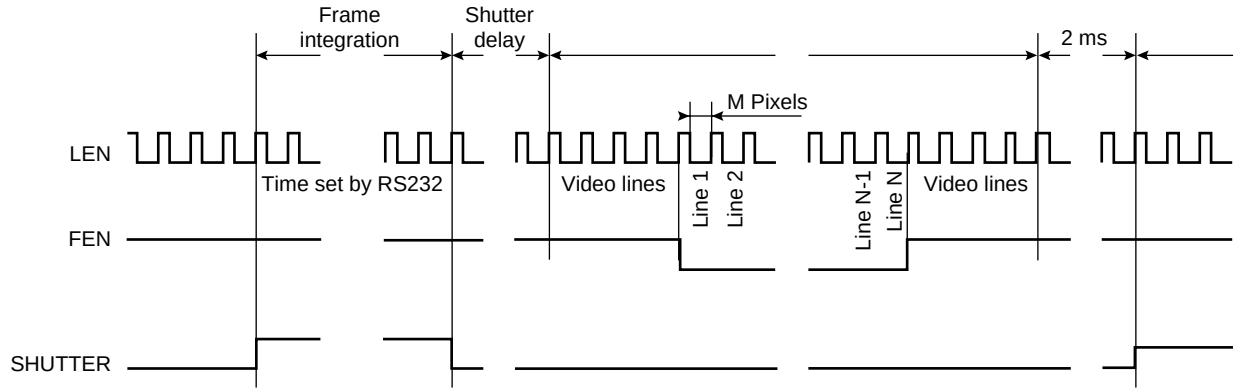
Notes:
1. Pixel is defined as valid (part of the Frame) when both LEN and FEN Signals are at Low Level.
2. The latency (called Td after) of 1 Readout line Time defined below depends on the binning mode. For no binning, this latency is around 104 µs.
3. Minimum Time at high level of LEN Signal is 10 µs (Transfer Time between two lines).
4. Minimum Time at high level of FEN Signal is 4 lines readout Time (around 416 µs).
5. Shutter Delay is adjustable via Commcam or RS232 commands (1, 5, 10 or 20 ms).

Continuous

The camera delivers frames continuously:

- Frame N+1 integration starts as soon as frame N readout is completed.
- Integration time is set by RS232.
- “Video Lines” (before and after valid frame) are 4+4 for Binning 1x1 (and also 1+1 for Binning 4x4).

Figure 3. Continuous Timing Diagram

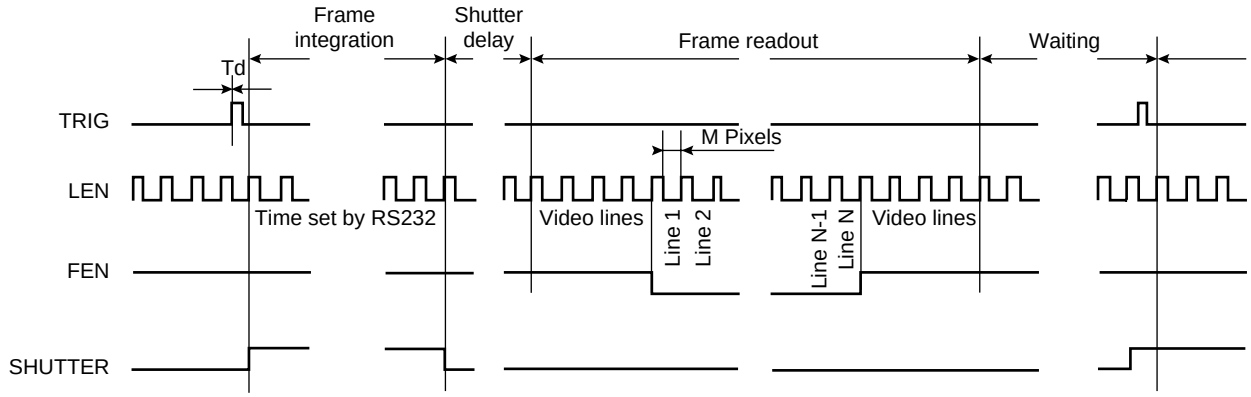


Operation with External Trigger

Integration start is controlled by the user from the external signal TRIG:

- The rising edge of TRIG activates the start of the frame integration. This rising edge is synchronized by the camera with a latency of Td (Time delay equivalent to a readout Time for a Line: See notes above).
- Integration time is set by RS232.
- Note: TRIG signal period must be greater than integration time plus frame readout time.
- “Video Lines” (before and after valid frame) are 4+4 for Binning 1x1 (and also 1+1 for Binning 4x4).

Figure 4. External Trigger Timing Diagram

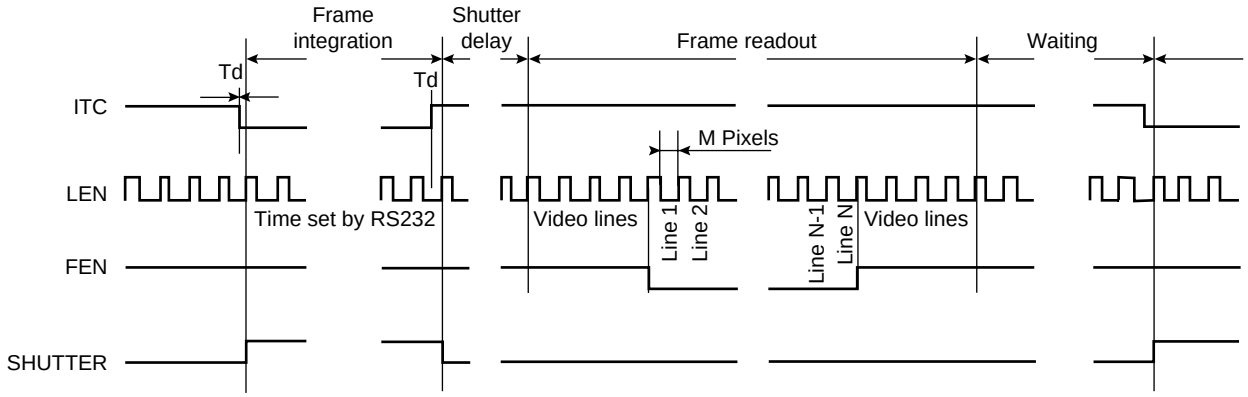


Operation with "Integration Time Control"

Integration is fully controlled by the user from the external signal ITC:

- The falling edge of ITC activates the start of the frame integration. This falling edge is synchronized by the camera with a latency of Td (Time delay equivalent to a readout Time for a Line: See notes above).
- The rising edge of ITC activates the stop of the frame integration. This rising edge is synchronized by the camera with the same latency of Td.
- Note: ITC signal period must be greater than integration time (defined by ITC low) plus frame readout time.
- “Video Lines” (before and after valid frame) are 4+4 for Binning 1x1 (and also 1+1 for Binning 4x4).

Figure 5. "Integration Time Control" Timing Diagram



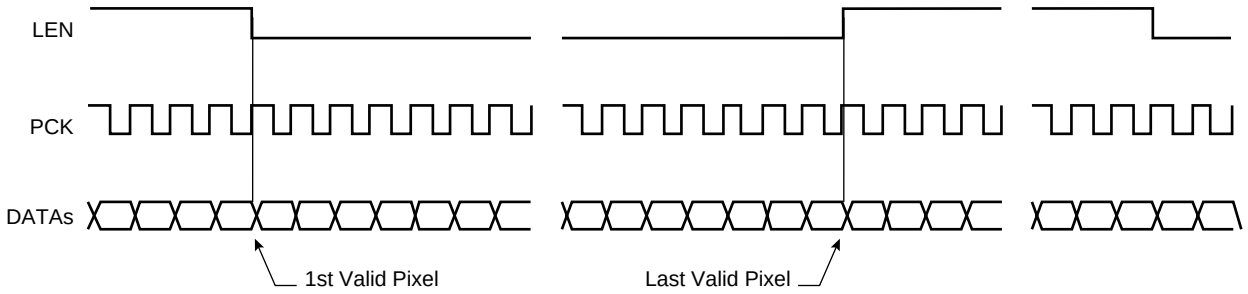
Line Timing

Duty cycle of the PCK is 50%.

Rising and falling edges: 1.5 ns.

Data rate is (Internal pixel clock): 25 MHz in binning mode 1x1.

Figure 6. Line Timing Diagram



R.O.I (REGIONS OF INTEREST)

Caution: This function is available only since the 5th October 2001 with the Camera S/N: 01321093. For older Cameras, these commands aren't available and can corrupt the EEPROM (see "Camera Identification" on page 13).

CAMELIA 8M (both Color and Black & White) can operate in a "multi ROI" mode allowing masking of regions of the image and thus increasing frame rate by a reduced readout time.

User defines up to 5 windows to be masked. In addition he specifies starting and ending addresses for each window.

Time reduction: about 92 µsec per masked line.

Two steps (under RS232 controls or Commcam):

- Enter the list of starting and ending addresses by the command: Y=ssss/eeee/ssss/eeee/…/eeee/
- Enter the number of regions masked by the command: F=X (X=0 to 5)

Rules

The line addresses must be a multiple of 4 (to be compliant with the binning).

The Image starts at Line 0 and ends at Line 3499 and the smallest area is of 4 lines.

The commands must be send in the following order: "Y=…" then "F=…".

For FGT Software Users, the user has to resize the number of lines in FGT settings.

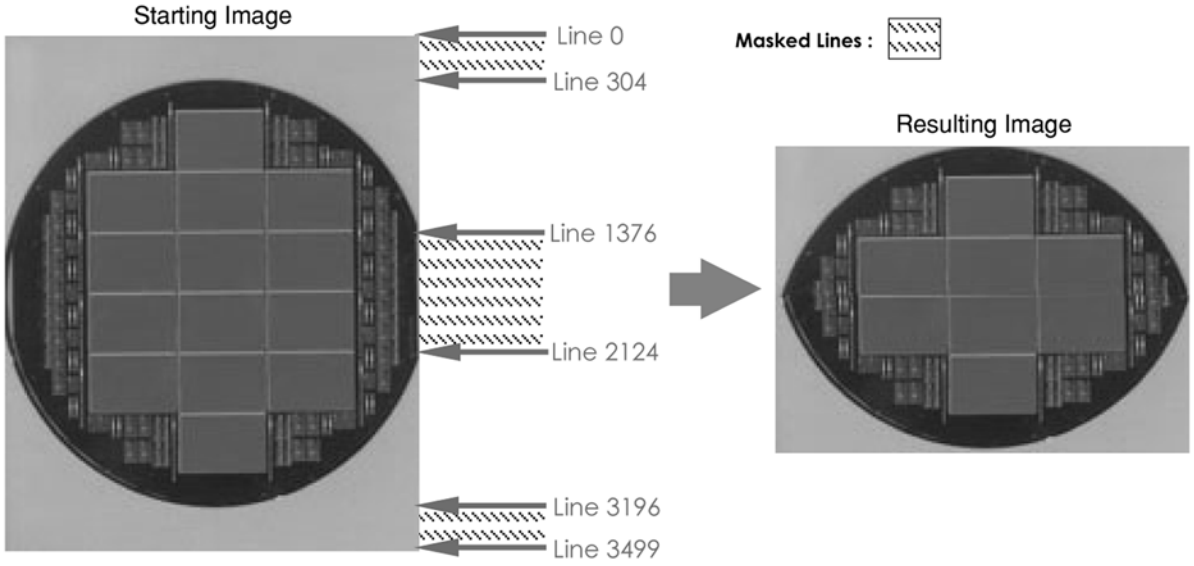
Example

In order to mask 3 regions in the "wafer image" defined as following:

- The First 304 lines at the top of the image (blue background)
- 748 lines in the center of the image (two center lines of the wafer)
- The last 304 lines of the image (blue background):
  - "Y=0/304/1376/2124/3196/3499/"
  - "F=3"

In this example readout time will be reduced of 1356 lines equivalent to 125 ms.

Figure 7. Readout Time



Electrical Interfaces

Digital I/O Specifications

Table 4. Digital I/O Specifications

Symbol	I/O	Definition	Level
TRIG_ITC	I	Timing control: - TRIG_ITC is either an external trigger or "integration time control" depending on the timing mode configured via RS232. Operation with external trigger: - TRIG_ITC = TRIG Operation with "integration time control": - TRIG_ITC = ITC - TRIG_ITC is synchronized by the camera line clock (jitter: 104 µs)	LVDS
PDATA(11..0)	O	Digital video output: 12-bit	LVDS
FEN	O	Frame enable: - FEN = 0: frame data valid: active lines - FEN = 1: frame data not valid	LVDS
LEN	O	Line enable: - LEN = 0: line data valid: active pixels - LEN = 1: line data not valid	LVDS
PCK	O	Pixel clock	LVDS
SHUTTER	O	Shutter open/close: - during integration: shutter = 1 - during readout: shutter = 0 Delay between the falling edge of shutter and the start of readout: - 4 positions: 1 ms, 5 ms, 10 ms, 20 ms (set via RS232).	LVDS
COLOUR_I(1..0)	I	Color selection of the next frame (in color mode): - "00": red - "01": green - "10": blue	LVDS
COLOUR_O(1..0)	O	Color identification of the current frame (in color mode): - "00": red - "01": green - "10": blue.	LVDS

LVDS drivers/receivers:

- LVDS: Low Voltage differential Signal. (EIA 644 standard). All digital I/Os are differential: (signal+, signal-). Specifications are given for signal +.
- Manufacturer NS.
- Driver: DS90C031TM (SO16 package).
- Receiver: DS90C032TM (SO16 package).

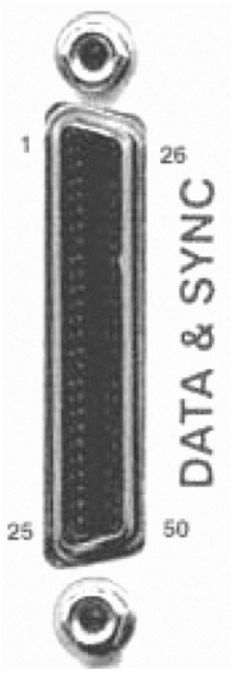
Digital I/O Cabling

50 pins connector.

Connector reference: HIROSE DX10A-50S.

Mating connector on cable side: HIROSE DX40-50P ; shell: HIROSE DX50-CV1.

Table 5. Digital I/O Pinout

Pin Number	Signal	Pin Number	Signal	
1	PCK+	26	LEN+	
2	PCK-	27	LEN-	
3	FEN+	28	COLOUR_O1+	
4	FEN-	29	COLOUR_O1-	
5	COLOUR_O2+	30	GROUND	
6	COLOUR_O2-	31	GROUND	
7	PDATA0+	32	PDATA1+	
8	PDATA0-	33	PDATA1-	
9	PDATA2+	34	PDATA3+	
10	PDATA2-	35	PDATA3-	
11	PDATA4+	36	PDATA5+	
12	PDATA4-	37	PDATA5-	
13	PDATA6+	38	PDATA7+	
14	PDATA6-	39	PDATA7-	
15	PDATA8+	40	PDATA9+	
16	PDATA8-	41	PDATA9-	
17	PDATA10+	42	PDATA11+	
18	PDATA10-	43	PDATA11-	
19	GROUND	44	NC	
20	GROUND	45	NC	
21	SHUTTER+	46	TRIG_ITC+	
22	SHUTTER-	47	TRIG_ITC-	
23	COLOUR_I1+	48	COLOUR_I2+	
24	COLOUR_I1-	49	COLOUR_I2-	
25	NC	50	NC	

Notes: 1. NC : not connected.
2. A "Data + Sync" cable is provided with FGT Frame grabber. This cable allow interconnection between:
- The camera,
- The Electro-optical interface,
- The "FGT" frame grabber: see "FGT Frame Grabber user manual".

RS232 Controls

RS232 Specifications

Camera configuration is set by RS232 interface. The following features are available:

Table 6. RS232 Specifications

Function	RS232 Configuration	Comment	RS232 Command
Timing mode	3 modes: - continuous (free running) - external trigger - external ITC		 T=1 T=2 T=3
Binning	3 modes: - no binning - 2x2 pixel binning - 4x4 pixel binning	 Image size: 2300(H) x 3500(V) Image size: 1150(H) x 1750(V) Image size: 574(H) x 875(V)	 B=0 B=1 B=2
CDS gain	2 positions: - G = 1 - G = 4	G = 4 is recommended for applications requiring high sensitivity	 H=0 H=1
Shutter	2 modes: - active - inactive (always open)		 S=0 S=1
Shutter delay	4 positions: - 1 ms - 5 ms - 10 ms - 20 ms		 D=0 D=1 D=2 D=3
Anti-blooming control	2 modes: - active - inactive		 A=0 A=1
Black & white or color Mode	2 modes: - black and white - 3 shot color		 C=0 C=1
Black & white integration time	Integration time value in ms from 1 ms to 2000 ms Active in Monochrome	Must be an integer Ex: 120 for 120 ms 120.4 not allowed	Ex: I=120
Red integration time	Value in ms from 1 ms to 2000 ms Active only in "3 shot color" mode	Must be an integer Ex: 120 for 120 ms	Ex: J=120
Green integration time	Value in ms from 1 ms to 2000 ms Active only in "3 shot color" mode	Must be an integer Ex: 120 for 120 ms	Ex: K=120

Table 6. RS232 Specifications (Continued)

Function	RS232 Configuration	Comment	RS232 Command
Blue integration time	Value in ms from 1 ms to 2000 ms Active only in "3 shot color" mode	Must be an integer Ex: 120 for 120 ms	Ex: L=120
R.O.I[1] Number of Windows	0 to 5 windows		Ex: F=2
R.O.I[1] Windows Addresses	Line start/Line Stop …	Must be an integer divisible by 4 Line Stop >3 First Line = 0; Last Line = 3499	Ex: Y=1824/2252 /3156/3499/
Storage of the settings in EEPROM[2]	E=0: setting stored E=1: setting not stored	Effective after the send of the command	E=0

Notes: 1. R.O.I commands are available only since the 5th October 2001 with the Camera S/N: 01321093. For older Cameras, these commands aren't available and can corrupt the EEPROM. For any doubt, please contact hotline before using R.O.I function (See "Camera Identification" on page 13).
2. ATMEL recommends to use E = 1 because of the limited EEPROM write cycles refer on page 11.

Detail of the RS232 Commands

Command Syntax

- Valid syntax is: S=n(CR) with:
  - S: command identification: S is a single character in upper case
  - n: setting value
  - (CR): means "carriage return" (ASCII code = 13)
  - No spaces, nor tabs may be inserted between S, =, n and (CR)
  - For CAMELIA 8M only, each address value is ended by "/": Y=ssss/eeee/….eeee/
- Example of a valid command: I=500(CR): sets the Integration Time at 500 ms
- Example of non valid commands:
  - I=500(CR): spaces
  - i=500(CR): g instead of G
  - I=3000(CR): 3000 is out of range
  - Y=ssss/eeee/ssssseeee/: a "/" is missing

Storage of the Settings in EEPROM

We recommend to use ''E=1'' for settings that are often changed (check the maximum number of write cycles above) and when the time required by the camera to process a command is critical.

- The maximum number of write cycles allowed for the EEPROM is: 10 000.
- The time required to process a valid ''E=0'' command is around 50 ms.
- The time required to process a valid ''E=1'' command is around 12 ms.

Command Processing after ''E=0''

Each command received by the camera is processed:

- If the command is valid:
  - setting is done
  - setting is stored in EEPROM
  - the camera returns the setting
  - the camera returns: >OK(CR)
- If the setting value is out of range (command not valid):
  - nothing is done
  - the camera returns its current setting (i.e. the setting resulting from the last valid command)
  - the camera returns: >1
- If the syntax is not correct (command not recognized by the camera):
  - the camera returns: >2

Example of a valid command:

I=500(CR): sent by the user

I=0500(CR): returned by the camera

>OK(CR): returned by the camera

Note: the number of characters returned by the camera is always the same whatever the value of the setting is. For examples:

I=10(CR): sent by the user

I=0010(CR): returned by the camera

>OK(CR): returned by the camera

I=1500(CR): sent by the user

I=1500(CR): returned by the camera

>OK(CR): returned by the camera

Example of non valid commands:

I=3000(CR): sent by the user

I=0500(CR): returned by the camera (03: setting actually in camera)

>1(CR): returned by the camera: setting value out of range

M=2: sent by the user

>2(CR): returned by the camera: command not recognized by the camera

Command Processing after ''E=1''

Each command received by the camera is processed:

- If the command is valid:
  - setting is done
  - the camera returns: >OK(CR)
- If the setting value is out of range (command not valid):
  - nothing is done
  - the camera returns: >1
- If the syntax is not correct (command not recognized by the camera):
  - the camera returns: >2

Camera Identification

A character string stored in EEPROM gives the product model, its version and its serial number.

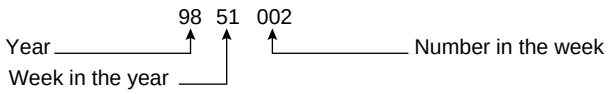
Example: CAMEL_COL_1.6M_01_9851002

stands for: CAMELIA COLOR 1.6M, version 01, serial number 9851002

It is read by sending: !=0(CR)

The serial number is detailed as following:

Figure 8. Serial Number



Customer Identification

Customer identification is a character string (25 characters max).

- It is set and stored in EEPROM by sending $=xx..xx
- It is read by sending !=1(CR)
- Customer identification is stored in EEPROM whatever the state of E.

Reading Current Settings

When receiving '!=3(CR)'' the camera returns its current settings.

Factory Configuration

When receiving ‘’!=4(CR)’’, the camera is factory configured and then sends back its settings:

A=0(CR)
C=0(CR)
H=0(CR)
S=1(CR)
B=0(CR)
T=0(CR)
I=0100(CR)
J=0100(CR)
K=0100(CR)
L=0100(CR)
D=2(CR)
E=0(CR)
F=0(CR) (Y not set)
>OK(CR)

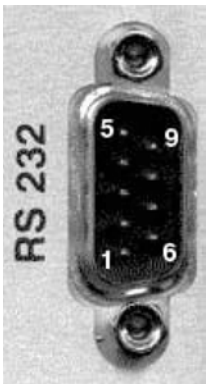
RS232 Cabling

On camera Dsub 9pins.

On computer side Dsub9 female, pin out compatible with computer serial port.

Pin out is the same on camera side and on computer side.

Table 7. RS232 Pinout

Pin Number At camera output	Signal	
1	NC	
2	RX	
3	TX	
4	NC	
5	GROUND	
6	NC	
7	TRS	
8	CTS	
9	NC	

Notes: 1. NC : not connected.
2. A "RS232" cable is provided with FGT Frame grabber.

Power Supply

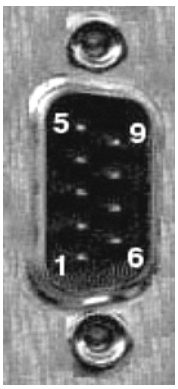
Power Supply Specifications

Table 8. Power Supply Specification

Parameter	Nominal Value	Min Value	Max Value
Voltage	+24V	+20V	+28V
Current	0.6A	nd	nd

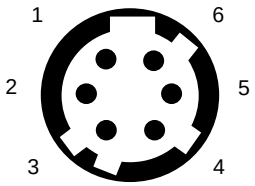
Power Supply Cabling

Table 9. Power Supply Pinout

Hirose 6 pins male HR10A-7R-6P	Pin Number At camera output	Signal	Pin Number At end of power supply cable	SUBD9 male
	5	+24V	1	
	6	+24V	2	
		NC	3	
		NC	4	
		NC	5	
	1	GROUND	6	
	2	GROUND	7	
		NC	8	
		NC	9	

Notes: 1. NC : not connected.
2. A "power supply" cable is provided with FGT Frame grabber.

Figure 9. Receptacle Viewed from Camera Back



Specifications

Definitions

LSB: Least Significant Bit: 12-bit correspond to 4095 LSB.

Absolute Maximum Ratings

Storage temperature:	-20°C to +70°C
Operating temperature:	0°C to +50°C
Operating humidity (non condensing):	< 80% at +35°C
Vibration:	2g sinusoidal, from 10 Hz to 100 Hz
Power supply:	+20V to +28V

Weight

900 g

Electro-optical Performance

Conditions: Camera operating free air temperature: 20°C

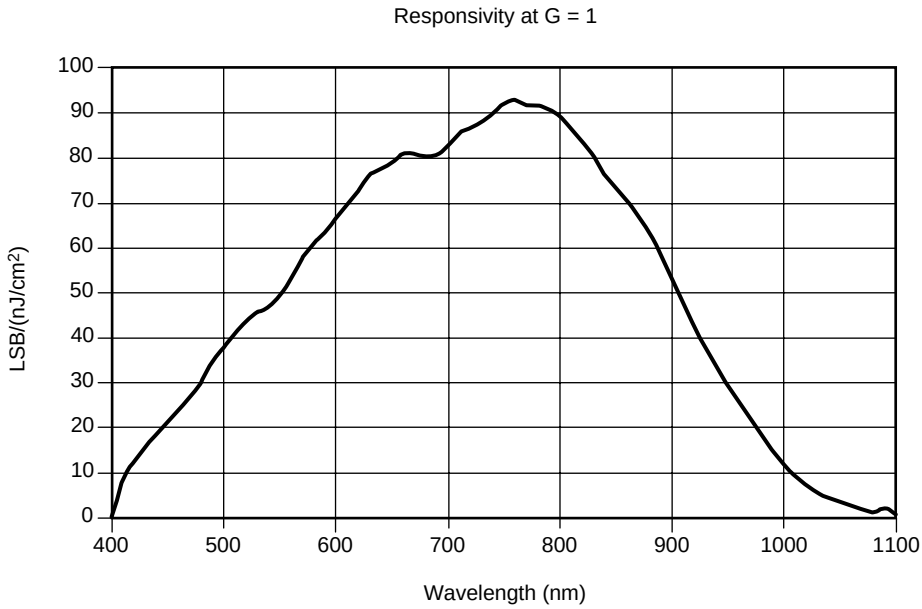
Table 10. Electro-optical Performance

Parameter	Symbol	Typical Value	Unit	Notes
Full scale value	VPE	4095	LSB	(1)
Temporal noise	VN	2.7	LSB	(2)(3)
Dark signal non uniformity	DSNU	2	LSB.s	(3)(4)
Dynamic range	DY	1500 63	 dB	(5)
Responsivity	R	51.43	LSB/(nJ/cm^2)	(6)
Resolution Horizontal Transfer function at Nyquist Vertical Contrast Transfer function at Nyquist	 CTFh CTFv	 40% 40%	 – –	(7)
Anti-blooming (over illumination capability)	–	8x	–	(8)
Electrons to LSB conversion	–	15	e-/LSB	
Current consumption	I	500	mA	(9)

Notes:
1. Full scale value VPE: maximum digital video signal.
2. Temporal noise VN: r.m.s value in darkness. Measured by subtracting 2 images pixel to pixel at 40 ms of integration time.
3. This parameter depends on integration time and on CCD temperature. Thermal noise doubles every 16°C of temperature elevation. Dark signal doubles every 8°C of temperature elevation. But a internal clamp correct the mean value of this phenomena.
4. Dark signal non uniformity: r.m.s value. Excludes blemishes.
5. Dynamic range DY = VPE/VN
6. Responsitivity conditions: CDS gain = 1x, 3200K, light source powered between 200 and 1100 nm, measured on the sensor.
7. Resolution conditions: VIDEO = 2000 LSB, CDS gain = 1x, 3200K with BG38 2 mm
8. Anti-blooming ON. Integration time = 100 ms.
9. Measured at 24V.

Spectral Responsivity

Figure 10. Spectral Responsivity



Note: nJ/cm^2 measured on the sensor.

Image Grade Specification

- Defect Sizes
  - Blemish: 1 x 1 defect.
  - Cluster: blemish grouping of not more than a given number of adjacent defects:
    1 x 1 < cluster 1 size ≤ 2 x 2
    2 x 2 < cluster 2 size ≤ 5 x 5
  - Column: one-pixel-wide column with more than 7 contiguous defective pixels.
  - Defect separation: defects are separated by no less than "D min" pixels in any direction.
- Defects in Darkness
  - Blemish or cluster: pixel(s) whose signal deviate(s) more than 150 LSB.
  - Column: column whose signal deviates more than 15 LSB.
- Defects under Illumination
  - Blemish or cluster: pixel(s) which deviate(s) by more than +20% or -30% from the "average" pixel.
  - Column: column which deviates by more than 10% from the "average" column.

Defect Test Conditions

- Room temperature = 20°C.
- Integration time in darkness = 100 ms.
- Light source: Halogen 3200K with BG38 (2 mm thick) IR cut- off with f/11 aperture.
- Test under illumination at 50% of saturation level.
- No software correction performed.
- Deviations specified with CDS gain = 1.

Classifications

Table 11. Image Grade Classifications

Grade	Blemishes		Cluster 1		Cluster 2		Column	
	Total	D min	Total	D min	Total	D min	Total	D min
E	≤ 500	3	≤ 30	50	≤ 6	100	≤ 5	150
H	≤ 300	3	≤ 10	50	0	–	0	–

Geometrical Specifications

Figure 11. With F Mount Ring

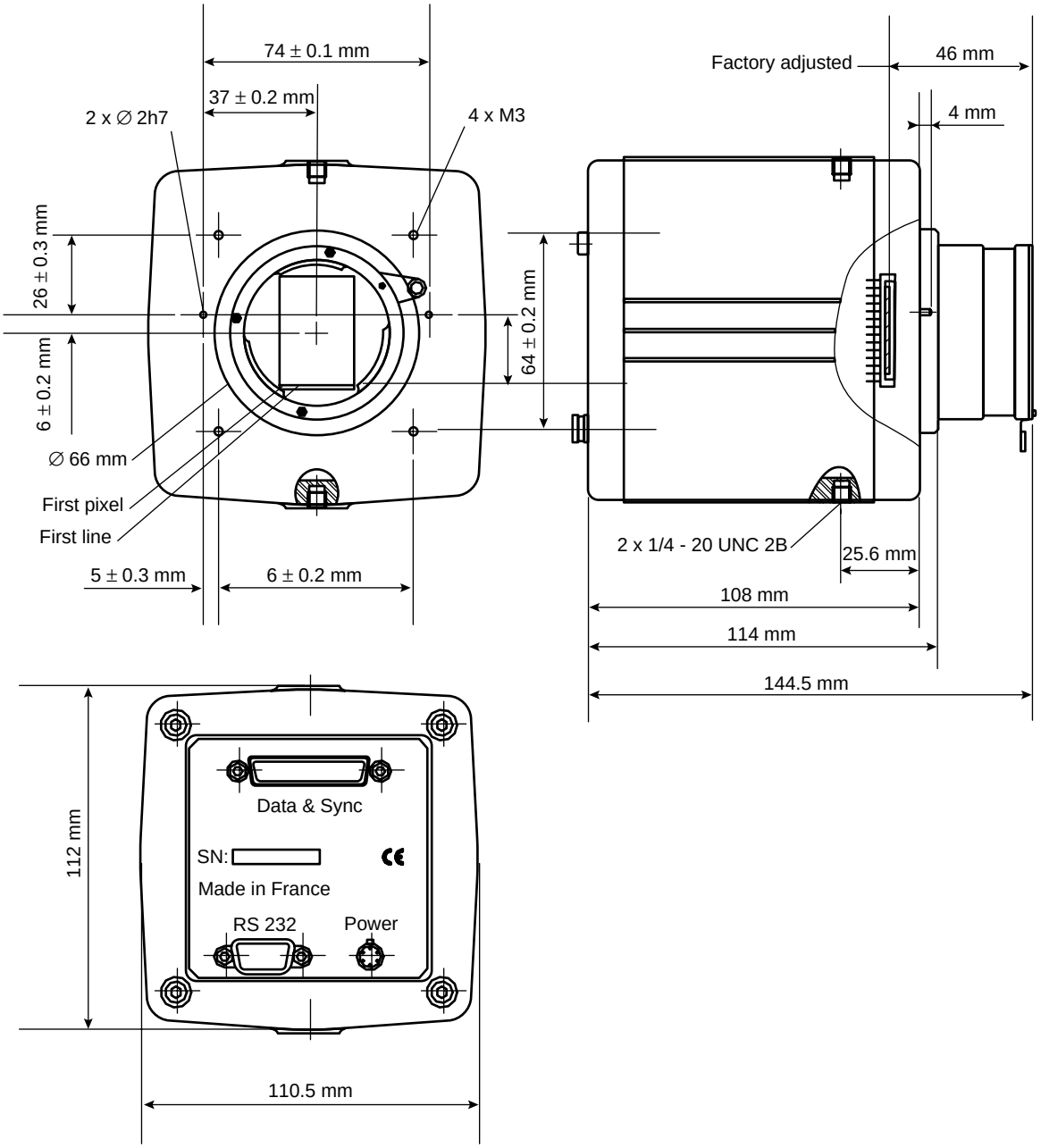
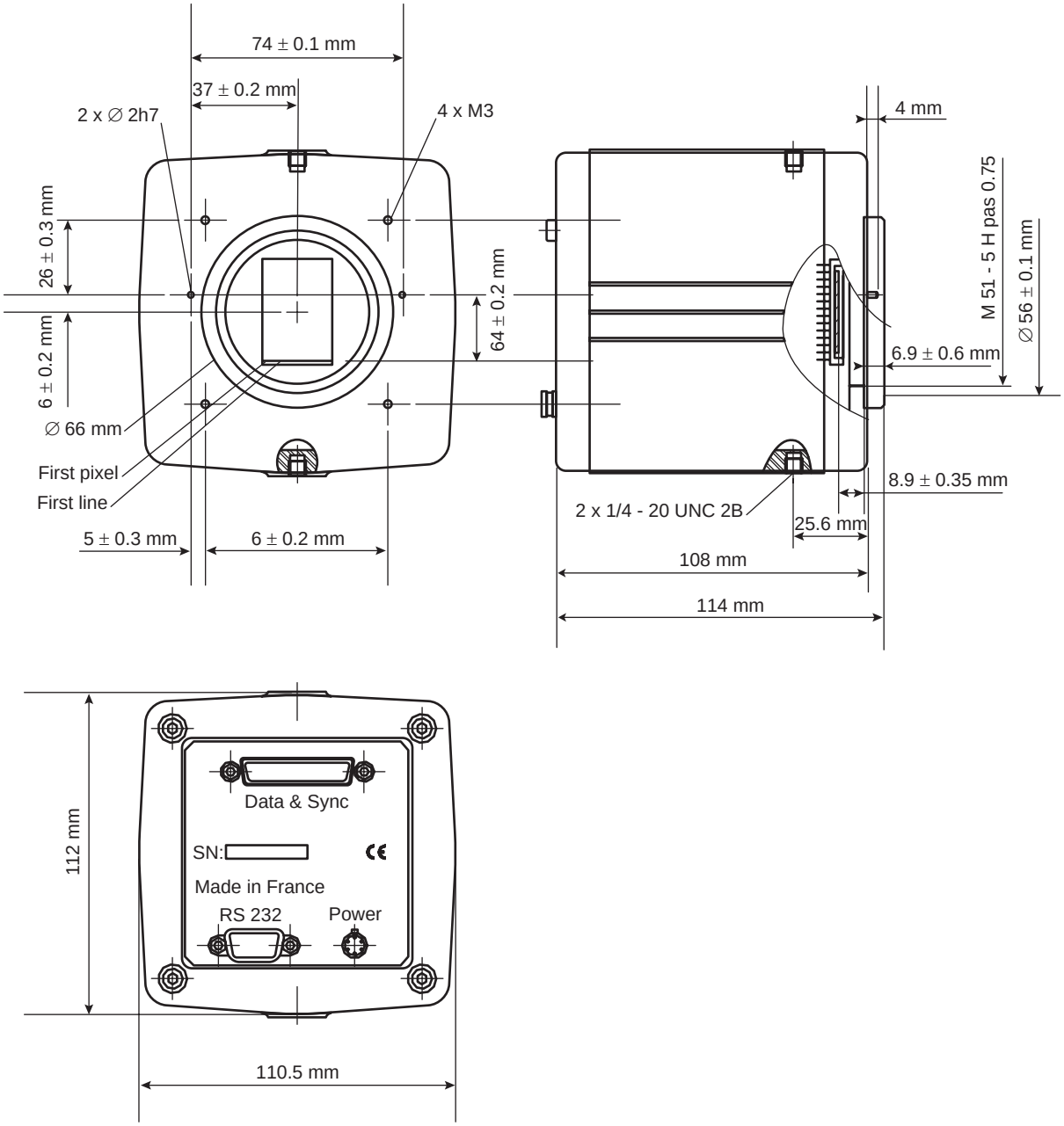


Figure 12. Without F Mount Ring



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